# Dichotomous Thinking Toward Food as a Mediator Between Eating Behavior and BMI

by

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ABSTRACT

Long-term results of dietary weight loss interventions are not promising, with rates of weight loss maintenance at a mere 20%. Psychological factors related to weight maintenance include setting unrealistic weight goals, poor problem-solving skills, low self-efficacy, dichotomous thinking, and external locus of control. The ability to maintain a stable bodyweight over time has been associated with optimal health outcomes, lower stress levels, and higher general well-being. Dichotomous thinking has been associated with overeating and increased bodyweight. Cognitive restraint, disinhibition, and hunger are three dimensions of human eating behavior that appear to be important to understanding weight loss maintenance. Individuals who attempt to maintain their bodyweight via dietary restraint mechanisms are more susceptible to excessive eating episodes. Disinhibition has been found to be the strongest predictor of weight gain, while the research on the association between hunger and bodyweight is mixed. This study sought to evaluate the relationship between dichotomous thinking toward food and various eating behaviors (binge eating, cognitive restraint, disinhibition, and hunger). A multiple regression analysis revealed that binge eating, cognitive restraint, disinhibition, and hunger were each significant unique predictors of higher body mass index (BMI). Higher levels of hunger predicted lower BMI, controlling for cognitive restraint, disinhibition, and binge eating. Mediation analyses revealed that dichotomous thinking mediated the relationships between binge eating and BMI, cognitive restraint and BMI, and disinhibition and BMI. Further analysis revealed that binge eating mediated the relationship between dichotomous thinking and BMI, indicating that thinking of food

in black-and-white could lead to higher rates of binge eating, and the excess calorie consumption could lead to increased BMI. The study findings suggest that a strong focus should be made to promote a more flexible attitude toward food in an effort to improve weight loss maintenance in the population.

To my parents: Thank you for fostering and always encouraging my love of learning.

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# INTRODUCTION

Long-term results of dietary weight loss interventions are not promising. Most participants experience success in the short-term, yet the majority are not able to maintain weight loss in the long-term (Anderson, Konz, Frederich, & Wood, 2001). Rates of weight loss maintenance, defined as losing at least 10% of initial bodyweight and maintaining the loss for at least one year, are at a mere 20% (Befort et al., 2008; Stevens, Truesdale, McClain, & Cai, 2006; Wing & Hill, 2001; Wing & Phelan, 2005). Although long-term weight loss maintenance appears to be a function of the extent to which health behavior is maintained, more research is needed to elucidate how, specifically, environmental and psychological factors contribute to weight maintenance.

In order to understand how long-term weight loss maintenance is established, it is important to identify the specific health behaviors involved, which include continued consumption of a low-energy diet, high levels of physical activity, and greater frequency of self-monitoring behaviors such as regular weighing (Butryn, Phelan, Hill, & Wing, 2007; Mai et al., 2018; McGuire, Wing, Klem, Lang, & Hill,1999; Shick et al., 1998). The longer individuals are actively participating in a weight loss program, the higher their adherence to weight loss behaviors, but as soon as treatment ends, they begin to regain the weight (Perri, Nezu, Patti, & McCann, 1989; McGuire, Wing, Klem, Lang, & Hill, 1999; Franz et al., 2007). To counter this, it has been suggested by Wing, Tate, Gorin, Raynor, and Fava (2006) that individuals who lose weight continue to participate in weight maintenance programs to help improve maintenance of weight loss.

There is no agreed-upon definition of weight loss maintenance in the scientific literature as the issue is complex and multi-faceted. Of course, the term suggests that

some amount of weight has been lost, and subsequently the weight loss has been sustained over a period of time. One definition is, 'losing at least 5% of baseline body weight between baseline and follow-up, and maintaining that weight or less for a further two years,' (Crawford, Jeffery, & French, 2000) and another is, 'achieving an intentional weight loss of at least 10% of initial body weight and maintaining this body weight for at least one year' (Wing & Hill, 2000). Still other researchers classify successful "losers" as those who regain fewer than two body mass index points following weight loss (Cuntz, Leibbrand, Ehrig, Shaw, & Fichter, 2001). In recent years, MacLean and colleagues (2015) have identified successful weight loss to mean participants achieving a 5-10% weight loss at the end of the intervention. To further complicate the problem, different studies utilize different criteria to measure weight change following a period of weight loss: mean weight regain, percent regain, or percent still maintaining a given amount (Perri et al., 2008; Svetkey et al., 2008; Wing, Tate, Gorin, Raynor, & Fava, 2006).

Understanding what factors contribute to making weight loss maintenance so difficult is a key component to comprehending how to not only lose the weight but keep it off over the long-term. This knowledge can influence the advice given and strategies employed by practitioners during the weight loss and weight maintenance phases.

**Weight Loss Maintenance**

Numerous studies have examined the behavioral variables associated with weight loss maintenance (Perri et al., 1984; Sciamanna et al., 2011; Wadden et al., 2011). Although weight regain appears to be in part a result of discontinued adherence to weight control behaviors (Foster & Wadden, 1994; Jeffrey et al., 2000), there are other factors to take into consideration, including psychological factors such as setting unrealistic weight

goals, poor problem-solving skills, low self-efficacy (Byrne, 2002), dichotomous thinking (Byrne, Cooper, & Fairburn, 2004), as well as an external locus of control (Williams, Grow, Freedman, Ryan, & Deci, 1996) and lack of use of positive reinforcement as a motivator (Williams, Earle-Richardson, Greeth, Scribani, & Monie, 2016). Indeed, psychological factors associated with regaining weight after dieting include feelings of failure for not achieving the expected weight loss, dissatisfaction with the weight achieved, a tendency to evaluate self-worth in terms of weight and shape, lack of vigilance with regard to weight control, a dichotomous black-and-white thinking style, and the tendency to use eating to regulate mood (Byrne, Cooper, & Fairburn, 2004). In contrast, successful weight maintenance is related to realistic goal setting, consistent routine and self-monitoring, minimizing deprivation, and effective coping skills (McKee, Ntoumanis, & Smith, 2013). Further, results from Brantley and colleagues (2014) suggested that perceptions of social support, functional and perceived physical health, functional and perceived mental health, and stress modestly predicted subjects' weight loss maintenance.

People's decisions regarding behavior change partly depend on favorable expectations of the future outcomes – specifically, expecting significant weight loss – while the maintenance of health behaviors depends strongly on the achieved results (Rothman, 2000). In both cases, however, the new behavior usually demands additional cognitive effort and limits to otherwise preferred foods and activities. Importantly, feelings of deprivation adversely affect long-term weight loss maintenance by decreasing adherence to the dietary protocol (Urban, White, Anderson, Curry, & Kristal, 1992).

Therefore, reducing dietary deprivation within any weight loss intervention may be an effective strategy to promote lasting results.

Carels and colleagues (2014) compared a weight loss program emphasizing reducing unhealthy relationships with food, body image dissatisfaction, and internalized weight bias called *New Perspectives*, to a weight loss program emphasizing environmental modification and habit formation and disruption called *Transforming Your Life*. At the end of the 12-week dietary intervention, weight loss outcomes were similar; however, *Transforming Your Life* patients were significantly more effective at maintaining weight loss through the 6-month post-intervention follow-up. This study suggests that long-term weight loss success might depend not on finding the perfect diet program so much as on understanding the nuances of psychological factors and health behaviors involved, and then applying those lessons so that individuals can modify their own lifestyle for the better.

**Yo-Yo Dieting**

Weight cycling, or yo-yo dieting, is defined as intentionally losing weight through energy restrictions and then gaining the weight back over time (Field et al., 1999). Reports of weight cycling prevalence in the United States vary from anywhere between 20-55% in women and 20-35% in men (Foreyt et al., 1995; Lahti-Koski, Männistö, Pietinen, & Vartiainen, 2005), largely because there is no operational definition of weight cycling (Atkinson et al., 1994).

The research on the relationship between yo-yo dieting and adverse health outcomes is mixed. Wadden et al. (1992) found zero association between total number of dieting attempts or total lifetime weight loss and self-reported depression, dietary

restraint, disinhibition, hunger, or binge eating. Other studies support the finding that a history of weight cycling has no impact on subsequent weight loss (Wadden et al., 1992; van Dale & Saris, 1989; Beeson et al., 1989; Palm, Schram, Swarts, van Schothorst, & Keijer, 2017). In contrast, Miller and Parsonage (1975) suggested that a long history of dieting made weight loss less likely in women, and other studies have similarly suggested that participation in weight loss programs was a negative predictor of subsequent weight loss (Jeffrey et al., 1984; Jeffrey et al., 1985). Smith and Wing (1991) found that weight loss decreased dramatically from the first diet cycle to the second in a year-long behavioral weight reduction program. Other research has shown relationships between weight cycling and cardiovascular morbidity and mortality (Brownell et al., 1994; Lissner et al., 1990; Blair et al., 1993; Hamm et al., 1989; Kannel et al., 1991) and increased risk of hypertension (Guagnano et al, 2000).

Wallner et al. (2004) showed that weight cycling induces a redistribution of body fat in women to a more android fat pattern, in which body fat is distributed around the trunk and upper body, compared to a gynoid fat pattern, in which body fat is distributed around the lower body, in normal weight, non-weight cycling women. These findings are consistent with previous studies that found increased waist-to-hip ratio, which is the most important and consistent factor associated with risk of hyperextension, and increased upper body fat distribution due to weight cycling (Guagnano, Ballone, & Pace-Palitti, 2000; Rodin, Radke-Sharpe, Rebuffe-Scrive, & Greanwood,1990). Of greater concern, Montani, Schutz, and Dulloo (2015) have identified numerous adverse health consequences associated with weight cycling, including but not limited to: increased anxiety and depression as well as increased risk of morbidities such as type 2 diabetes,

hypertension, and cancer. Most importantly, these health effects were seen in not just obese individuals but also those who were engaged in repeated dieting and weight cycling, including athletes and other individuals with normal body weight (Montani, Schutz, & Dulloo, 2015). More recently, in a 12-year cohort study, Madigan, Pavey, Daley, Jolly, & Brown (2018) found that weight cycling was associated with greater long-term weight gain and poorer mental health outcomes, and data collected by Pacanowski and colleagues (2018) suggest that poorer psychological function precedes weight instability.

Despite the conflicting research, the ability to maintain a stable bodyweight over time has been associated with optimal health outcomes (van der Kooy, Leenen, Seidell, Deurenberg, & Hautvast, 1993) in addition to lower stress levels and higher general well-being (Foreyt et al., 1995). Thus, further increasing our understanding of how and why weight cycling occurs is important.

**Dichotomous Thinking Toward Food**

Dichotomous thinking is characterized by the propensity to view situations in polarized either-or categories. The ability to think in this manner can be helpful for expedient, straightforward decision making in everyday life (Oshio, 2009). Indeed, dichotomous outcomes are common in society – vote yes or no, defendants are guilty or not guilty, and so on. However, while this all-or-nothing approach can be helpful in reaching conclusions quickly, it can also have negative psychological outcomes and less than desirable impacts on eating behavior.

This polarized thinking has also been found to be associated with depression (Teasdale et al., 2001), anxiety (Clark, 1986), and traits associated with eating disorders

and perfectionistic tendencies (Shafran, Cooper, & Fairburn, 2002). Those who set unrealistically high expectations for themselves when it comes to their diet and bodyweight typically evaluate themselves based on their adherence to said standards (Shafran, Cooper, & Fairburn, 2002). Though research at this time is limited, dichotomous thinking has been implicated as a psychopathological process in eating disorders (Fairburn, Cooper, & Shafran, 2003; Garner & Bemis, 1982). On the more extreme end, those suffering from anorexia nervosa, which is an eating disorder characterized by extreme dietary restriction and severe loss of bodyweight, exhibit a high degree of dichotomous thinking (Drewnowski, Pierce, & Halmni, 1988). More generally, those with eating disorders exhibit a dislike of high-fat foods (Rosen, Leitenberg, Fisher, & Khazam, 1986; Russell, 1967) and an irrational fear of starchy foods, dubbed "carbohydrate phobia" (Crisp & Kalucy, 1974). Byrne, Cooper, and Fairburn (2004) found dichotomous thinking to be a significant predictor of weight regain, both by lending to the development of rigid dietary rules, and also by subsequent binge eating when said rules have been broken. That is, the "all-or-nothing" attitude towards food choices that labels some foods as "good" and others as "bad" seems to lead to overeating in response to even minor dietary transgressions (Lethbridge, Watson, Egan, Street, & Nathan, 2011; Ramacciotti et al., 2008). It is thus believed that dichotomous thinking toward food may have a negative impact on the ability to achieve and maintain a desirable bodyweight.

Westenhoefer (1991) found that those who engaged in regimented eating behaviors, characterized by dichotomous thinking toward food, had a higher likelihood of overeating. He identified two patterns of dieting behaviors, flexible control, consisting of

behaviors such as decreasing portion sizes after breaking a diet and being conscious of overall food intake, and strict dieting, identified as rigid control of dieting. Further, rigid control has been found to correlate with weight instability and symptoms of bulimia nervosa, while flexible control has been found to be negatively correlated with BMI (Shearin, Russ, Hull, Clarkin, & Smith, 1994). Consistent with this research, Smith, Williamson, Bray, and Ryan (1999) found that flexible dieting was associated with the absence of overeating and lower BMI as well as lower levels of depression and anxiety. In addition to a correlation between flexible control and BMI, Stewart, Williamson, and White (2002) found that rigid dieting strategies were significantly associated with symptoms of mood disturbances, eating disorders, and excessive concern with body shape and size, while flexible dieting strategies were not highly associated with these outcomes. Significantly, there is emerging evidence that a more flexible (as opposed to rigid) restraint eating behavior could lead to better weight loss maintenance (Sairenan, Lappalainen, Lapveteläinen, Tolvanen, & Karhunen, 2014).

Dietary restraint has been found to be positively correlated to increased levels of eating-specific dichotomous thinking (Palascha, van Kleef, & van Trijp, 2015; Tiggemann, 2000). It has been proposed that dichotomous thinking mediates the relationship between dietary restraint and binge eating by contributing to the formation of rigid dietary rules and increasing the probability of disordered eating, and is believed by some cognitive-behavioral theorists to perpetuate the eating disorder cycle (Fairburn, Cooper, & Shafran, 2003). Those who think in this black-and-white manner tend to view even the most minor dietary transgressions, such as having one unplanned bite of a

cookie, as a total failure, and then proceed to temporary abandon their rigid self-imposed dietary rules (Fairburn, Cooper, & Shafran, 2003).

**Binge Eating**

Binge eating has been defined as the consumption of "large or enormous quantities of food in short periods of time" (Loro & Orleans, 1981, p. 156). Unlike a simple overeating episode, however, binge eating is associated with excessive eating as well as loss of control over eating (Kober & Boswell, 2017).

The cognitive behavioral theory of binge eating proposes that binge eating is the result of two primary factors: form of dietary restraint and the presence of an energy deficit (Fairburn, Cooper, & Shafran, 2003; Hawkins & Clement, 1980; Marcus, Wing, & Lamparski, 1985; Wardle & Beinart, 1981). Binge eaters tend to adhere to rigid and extreme dietary rules instead of general guidelines about how to eat, typically dropping their calorie intake well below what is necessary to lose weight. When even the most minor dietary transgression occurs, the individual tends to be triggered to binge eat, thus leading to a pattern of behavior in which the individual is exercising high dietary restraint followed by episodes of binge eating.

Frequent binge eating is a diagnostic feature of Binge Eating Disorder (BED) and other forms of eating pathology, and BED is the most prevalent eating disorder diagnosis, with 3.5% of adults in the US (Hudson et al., 2010; Hudson, Hiripi, Pope, & Kessler, 2007; Kessler et al., 2013; Sysko et al., 2012) diagnosed with BED. The prevalence and frequency of binge eating increases as bodyweight goes up (Telch, Agras, & Rossiter, 1988), with approximately 8% of overweight and obese adults (Bruce & Agras, 1992; Spitzer et al., 1992) afflicted in their lifetime. Moreover, between 20% and 30% of

individuals who are overweight or obese and seeking weight loss treatment have BED (Striegel-Moore & Franko, 2003). Amongst obese subjects attempting to lose weight, those who binge eat tend to struggle more with weight loss and regain the weight at a faster rate (Zelitch, 1993). In addition, obese subjects who binge eat may experience greater anxiety and depression and experience higher incidences of panic disorders and personality disorders (Marcus, Wing, & Hopkins,1988), and they also may have a negative distorted body image and preoccupation with their body shape and diet (Bruce & Wilfley, 1996).

Researchers hypothesize that strict dieting may increase feelings of hunger, deprivation, and self-denial, which then induce binge eating behavior (Loro & Orleans, 1981). Besides the psychological distress associated with this type of extreme behavior, binge eating significantly increases calorie intake (Guss, Kissileff, Devlin, Zimmerli, & Walsh, 2002), and this consequently increases bodyweight. In a 2002 study by Guss and colleagues, subjects were categorized according to body mass index and binge eating diagnosis and then were instructed to binge in one meal and eat normally during another. The subjects with binge eating disorder ingested significantly more calories during both meals than subjects without binge eating disorder (difference = 969 kcal ± 171 SE, $p < .001$), and there was a positive correlation between calorie content of meals and BMI ($p = .04$). While it may be that those with more severe binge eating problems may have higher bodyweight due to their overeating episodes, it may alternatively be the case that those with higher bodyweight diet more frequently and strictly, thereby making themselves more vulnerable to binge eating.

Binge eating episodes are often accompanied by feelings of disgust, shame, and guilt (Cooper & Fairburn 1987; Wolfe, Baker, Smith, & Kelly-Weeder, 2009). To receive a BED diagnosis, binge eating episodes must be associated with three of the following characteristics: 1) eating much more rapidly than normal; 2) eating until feeling uncomfortable full; 3) eating large amounts of food when not feeling physically hungry; 4) eating alone due to feeling embarrassed of how much one is eating, and 5) feeling disgusted with oneself, depressed, or very guilty after overeating (American Psychiatric Association, 2000).

Binge eating severity is determined by the number of binge eating episodes per week, and severity may also be increased according to functional impairments or emotional dysregulation (APA, 2013). There is conflicting research on the clinical validity of these severity markers, however; Dakanalis, Riva, Serino, Colmegna, and Clerici (2017) found that participants with different levels of binge eating severity differed significantly from each other in BMI, eating disorder features, and psychological distress. Similarly, Gianini and colleagues (2017) found that measures of eating pathology and self-reported physical and emotional dysfunction increased across binge eating severity groups. However, Nakai and colleagues (2017) did not find that the severity groups differed in any eating pathology variables besides level of eating concern. Despite these conflicting results, the evidence consistently suggests that those who struggle with eating disorders tend to engage in emotionally-driven eating, or eating in response to emotions, which has been associated with increased anxiety and depression (Goossens, Braet, van Vlierberghe, & Mels, 2009; Masheb & Grilo, 2006; Ricca et al., 2009). In addition, those with binge eating disorder have greater impulsivity and lower

emotion regulation capacities (Brockmeyer et al., 2014; Leehr et al., 2018) as well as increased impulse toward reward and inhibitory control deficits (Balodis, Grilo, & Potenza, 2015; Hege et al., 2014; Svaldi, Naumann, Trentowska, & Schmitz, 2014).

Weight cyclers with severe binge eating behaviors have higher psychological distress and depression and lower self-esteem, and they also report more hunger and use less cognitive restraint than those with no binge eating to moderate binge eating problems (Kensinger, Murtaugh, Reichmann, & Tangney, 1998). Specifically, Kensinger, Murtaugh, Reichmann, and Tangney (1998) found that 58% of weight cyclers in a sample population had binge eating disorder, and those with binge eating disorder scored higher on binge eating and disinhibition and scored lower on eating self-efficacy in addition to using less healthful coping strategies. They also reported using less cognitive restraint and more hunger than those with lower levels of binge eating problems. Osborn, Forys, Psota, and Sbrocco (2011) similarly found that weight cyclers had higher BMI, higher peak weight, and poorer self-esteem, though blood pressure did not differ between weight cycler and non-cyclers.

**Cognitive Restraint, Disinhibition, and Hunger**

Cognitive restraint is defined as "cognitive control of eating behavior" (Stunkard & Messick, 1985) and refers to the tendency to deliberately restrict one's food intake in order to control body weight. Chronic self-deprivation may predispose high restraint eaters to episodes of disinhibition and overeating of "forbidden," fattening foods such as ice cream and cookies (Polivy, 1996). This is demonstrated in the World War II study by Keys, Brožek, Henschel, Mickelsen, and Taylor (1950), in which normal weight men voluntarily restricted their eating for 6 months and lost one quarter of their starting

bodyweight in order to ascertain the effects of starvation. To accomplish this weight loss, their food intake was restricted by 25%, and when weight loss stalled, their intake was further restricted. In the months following the conclusion of the 6-month eating restriction period, a few observations emerged: the subjects became increasingly irritable and focused on food and their libidos dropped. Most notable, however, was the change in their eating behavior after the study: when they were allowed to consume food ad libitum again, their consumption of highly palatable foods increased drastically, and they reported feeling obsessed with food and out of control with their food intake (Franklin, Schiele, Brozek, & Keys, 1948; Schiele & Brožek, 1948). This pattern of behavior has been found in numerous other instances (Coscina & Dixon, 1983; Polivy, 1996; Stunkard, 1993), and patients with anorexia nervosa frequently later become bulimic, swinging between periods of starvation and uncontrollable eating (Garfinkel, Moldofsky, & Garner,1980). This loss of control over eating behavior demonstrates a drop in cognitive restraint.

The difference between restrained eaters and unrestrained eaters was again demonstrated in Herman and Mack's study (1975) involving female undergraduate participants at Northwestern University. The experiment involved the participants consuming either zero, one, or two milkshakes and then taste-testing some ice cream. The researchers surreptitiously recorded the participants' ad libitum ice cream intake. Those who scored low in dietary restraint behaved according to normal energy regulation: after consuming the milkshake pre-load, they subsequently consumed less ice cream. Those who scored high in dietary restraint, however, consumed significantly more ice cream after consuming the milkshake preload ($p < .005$). Just one milkshake was sufficient to

eliminate dietary restraint in the high restraint subjects; there was no difference in ice cream intake following consumption of one or two milkshakes. It appeared that the presence of external cues – in this case, the milkshake preload – was sufficient for the high dietary restraint individuals to abandon their restraint, and additional eating was triggered (Knight & Boland, 1989).

According to Nisbett's model (1972), high restraint individuals strive to maintain their bodyweight through the utilization of dietary restraint mechanisms, but they are more likely to give into the temptation of external cues. On the other hand, low restraint individuals are able to maintain their bodyweight without having to exercise dietary restraint. Stunkard and Messick (1985) thus suggested that it was not the degree of overweight, but rather the degree of dietary restraint, that determined individuals' eating behavior. Another study by Polivy, Coleman, & Herman (2005) found that depriving high restraint eaters of chocolate for a week led to significantly higher cravings and higher consumption of said food when it was later made available. Indeed, restrained eaters are far more likely than unrestrained eaters to give into a food craving when primed (Fedoroff, Polivy, & Herman, 2003).

The evidence thus seems to suggest that restrained eating increases one's susceptibility to excessive eating episodes, even when the restriction is later removed and bodyweight is restored to pre-restriction levels (Polivy & Herman, 1985). In particular, dieting seems to precede binge eating chronologically via increased cognitive restraint, which then makes the individual more vulnerable to disinhibited eating, which is characterized by a tendency to engage in periodic overeating (Westenhoefer, Broeckmann, Münch, & Pudel, 1994) and subsequent overeating (Polivy & Herman,

1985). Further research suggests that those who score high in restrained eating may be more likely to implement unhealthy or extreme dieting methods, independent of their weight status (Polivy & Herman, 1985; Heatherton, Herman, Polivy, King, & McGree, 1988).

Uncontrolled, disinhibited eating is a risk factor for overweight and obesity (Provencher, Drapeau, Tremblay, Després, & Lemieux, 2003) and predicts future weight gain (Nederkoorn, Smulders, Havermans, Roefs, & Jansen, 2006). This behavior can occur in response to numerous stimuli and under different circumstances, including being under emotional distress or being in the vicinity of palatable foods. A longitudinal study by Legenbauer and colleagues (2018) found that disinhibited eating mediated the relationship between self-reported impulsivity and bodyweight. Interestingly, disinhibited eating has been found to be a strong predictor of weight gain, whereas neither dietary restraint nor hunger were significant predictors (Hays et al., 2002; Lawson et al., 1995). In contrast, Provencher and colleagues (2003) found that perceived hunger was positively associated with BMI, and this finding has been supported by previous research (Boschi, Iorio, Margiotta, D'Orsi, & Falconi, 2001; Karlsson et al., 1994; Lindroos et al., 1997). Karlsson and colleagues (1994) further found that as participants experienced weight loss and then weight stabilization in a dietary intervention, their susceptibility to hunger decreased. McLean and Barr (2003) found no differences between different levels of dietary restraint and hunger, but there was a positive correlation between restraint and disinhibition.

## Study Aims

The primary goal of this cross-sectional study is to explore the mediating role of dichotomous thinking toward food between various eating behaviors and BMI.

In light of the previous research, the following hypotheses have been derived:

1) Binge eating will predict higher BMI.
2) Cognitive restraint, disinhibition, and hunger will uniquely predict higher BMI.
3) Dichotomous thinking will mediate the BMI-binge eating, BMI-disinhibition, and BMI-cognitive restraint relationships.

# METHODS

## Participants

Participants were recruited from all over the world through online platforms, including Facebook, Instagram, and Twitter. To be eligible, participants had to be female aged 21 or over. A link to the study was provided in the biography section of the Instagram account and posted numerous times on the Facebook page and Twitter account, plus an online newsletter. Further, personal contacts of the researcher were asked to post the link to the study on their own social media platforms. All participants were asked to complete an online survey administered via Qualtrics between November 30, 2017 and December 3, 2017. Ethics approval was granted by Institutional Review Board at Arizona State University.

**Measures**

*Dichotomous thinking toward food***.** The 4-item Eating subscale of the Dichotomous Thinking in Eating Disorders Scale (DTEDS; Byrne et al., 2008) is a self-report measure that assesses dichotomous thinking with eating, dieting, or bodyweight. Sample items include "I think of food as either 'good' or 'bad'" and "I view my attempts to diet as either successes or failure" and are rated on a four-point scale ranging from 1 (never) to 4 (always).

*Cognitive restraint, disinhibition, and hunger***.** The Three-Factor Eating Questionnaire (TFE-Q; Stunkard & Messick, 1985) is a 51-item self-report questionnaire that measures three dimensions of eating behavior: cognitive restraint of dieting, disinhibition, and hunger. Sample items include "Dieting is so hard for me because I just get too hungry" and "Would a weight fluctuation of 5 lbs affect the way you live your life?" Each question loads onto one of the three eating behavior dimensions. Scores from each question are summed, and the total score is indicative of higher levels of each respective factor. Cronbach's α was .90 for Factor I (cognitive restraint of dieting, 20 items), .87 for Factor II (disinhibition, 19 items), and .82 for Factor III (hunger, 20 items).

*Binge eating.* The Binge Eating Scale (BES; Gormally, Black, Daston, & Rardin,1982) is a 16-item self-report measure designed to identify the behavioral, cognitive, and emotional features of objective binge eating in overweight and obese adults. The BES is used as a brief screening tool to identify the severity of binge eating behavior. For each item, respondents are asked to select one of three or four response

options, coded zero to two or three, respectively. A higher total score is indicative of more severe binge eating. In this study, Cronbach's α was .85.

**Procedure**

The questionnaire was distributed through social media channels and professional contacts of the researcher. There was no compensation provided. Participants (n = 4,094) read a description of the study and then gave passive content by continuing to complete the survey. The survey took approximately 20 minutes to complete.

Prior to data analysis, a re-coding procedure was performed such that each answer in the questionnaire was assigned its appropriate numeric value. After reverse-scoring the appropriate items, composite scores for the Dichotomous Thinking Toward Food Scale, cognitive restraint, disinhibition, and hunger subscales of the Three-Factor Eating Questionnaire, and Binge Eating Scale were computed and totaled. Scale totals were used in analysis.

A multiple regression analysis was conducted in order to test the relationship between the predictive efficacy of binge eating, cognitive restraint, disinhibition, and hunger on BMI. Mediation analyses were also conducted to examine whether dichotomous thinking mediates the relationship between BMI and the various eating behaviors, and then a reverse mediation analysis was conducted to explore the mediating role of binge eating between dichotomous thinking and BMI.

## RESULTS

A total of 4,094 surveys were collected. Data from 100 respondents were excluded from analysis because they listed their gender as male, and data from 43 respondents were excluded from analysis because the time to complete the survey was

extremely short or long. Specifically, participants whose duration to complete the survey was longer than three standard deviations above the mean (14,742 s) were removed from analysis. There were no participants whose duration to complete the survey was shorter than three standard deviations below the mean. Thus, the final sample for the analyses reported below included 3,951 female online community participants. The mean age of participants was 34.63 years (*SD* = 8.61) and the mean height was 1.64 m (*SD* = 0.40), ranging between 1.22 m to 2.03 m. Forty-two percent of participants were college graduates, 24.8% had a post-graduate degree, 18.7% had obtained some college credit, 9.2% had some post-graduate work, 4.6% had a high school diploma or the equivalent, and 0.8% had some high school education. A summary of the participant demographics is presented in Table 1.

The mean BMI of the participants was 27.70, which is classified in the overweight category. Two percent of participants were underweight, 42.6% were normal weight, 25.5% were overweight, and 29.9% were obese. These figures are lower than the self-reported obesity prevalence in the United States, with 35.8% of women falling into the obese category (Flegal, Carroll, Kit, & Ogden, 2012).

Of the 3,951 participants, 81% indicated that they had lost weight over the past 5 years; of those, 58.3% noted that they had regained 10 lbs or more back. Thus, 47.2% of participants were classified as yo-yo dieters (Field et al., 1999; Gaugnano, Ballome, & Pace-Palitti, 2000; Montani, Viecelli, Prévot, & Dulloo, 2006). Thirty-eight percent of participants were on a diet at the time the survey was taken. Of the 61.2% who were not on a diet at the time the survey was taken, 47.7% had ended their diets more than 12 months prior, 15.4% had ended their diets between 3-6 months ago; 13.5% had ended

their diets less than 3 months ago; 11.9% had ended their diets 9-12 months ago; and 11.5% had ended their diets 6-9 months ago.

*Regression Analysis*

To investigate the effects of cognitive restraint, disinhibition, hunger, and binge eating on BMI, a multiple regression was performed in which cognitive restraint, disinhibition, hunger, and binge eating were entered as predictors of BMI. Overall, the predictors jointly accounted for a statistically significant proportion of the variability in BMI scores ($R^2 = .16$, $F(4, 3851) = 188.40$, $p < .001$).

All four variables in the model were significant unique predictors of BMI, explaining 16% of the variance. That is, higher levels of cognitive restraint were associated to lower BMI ($b_1 = -0.28$, $p < .001$); conversely, higher levels of disinhibition ($b_2 = 0.48$, $p < .001$); higher levels of hunger ($b_3 = -0.17$, $p < .001$); and higher levels of binge eating predicted higher BMI ($b_4 = 0.13$, $p < .001$). Results from the regression analysis are presented in Table 4.

*Mediation Analyses*

Mediation analyses were conducted to examine whether dichotomous thinking toward food mediates the relationship between (a) BMI and binge eating, (b) cognitive restraint and BMI, and (c) disinhibition and BMI.

The first mediation analysis examined the extent to which the relationship between binge eating and BMI would be mediated by DTES controlling for cognitive restraint, disinhibition, hunger, and yo-yo dieting. A bootstrapping procedure (with 5,000 biased corrected samples) with PROCESS found that the indirect effect of binge eating on BMI was $ab = 0.11$. The 95% confidence interval, (0.01, 0.04) did not include zero,

therefore indicating a statistically significant mediation pathway at the $p < .05$ level. The direct effect of binge eating on BMI controlling for DTES remained significant ($c' = 0.11$, $SE = 0.02$, t(3849) = 5.69, $p < .001$).

The second mediation analysis examined the extent to which the relationship between cognitive restraint and BMI would be mediated by DTES controlling for disinhibition, hunger, binge eating, and yo-yo dieting. The 95% confidence interval for the indirect effect of cognitive restraint on BMI, (0.01, 0.03), did not include zero, therefore indicating a statistically significant mediation pathway at the $p < .05$ level. The direct effect of cognitive restraint on BMI controlling for DTES was significant ($c' = -0.29$, $SE = 0.02$, $t(3849) = -12.15$, $p < .001$).

The third mediation analysis examined the extent to which the relationship between disinhibition and BMI would be mediated by DTES controlling for hunger, yo-yo dieting, binge eating, and cognitive restraint. The 95% confidence interval, (0.01, 0.03), did not include zero, therefore indicating a statistically significant mediation pathway at the $p < .05$ level. The direct effect of disinhibition on BMI controlling for DTES was significant ($c' = 0.46$, $SE = 0.04$, t(3849) = 10.45, $p < .001$).

A fourth exploratory mediation analysis was conducted that examined the extent to which the relationship between hunger and BMI would be mediated by DTES controlling for yo-yo dieting, binge eating, cognitive restraint, and disinhibition. The 95% confidence interval, (-0.005, 0.004), did include zero, therefore indicating a non-significant mediation pathway at the $p < .05$ level. The direct effect of hunger on BMI controlling for DTES, however, was significant ($c' = -0.17$, $SE = 0.04$, t(3849) = -4.72, $p < .001$).

Given the cross-sectional nature of the data, a reverse mediation model was also examined in which binge eating was entered as a mediator rather than predictor variable controlling for cognitive restraint, disinhibition, hunger, and yo-yo dieting, as it may be the case that binge eating helps to explain the relationship between dichotomous thinking and BMI. Results from the reverse mediation model are presented in Figure 5. Binge eating mediated the relationship between dichotomous thinking and BMI, with the significance of the indirect effect confirmed by a 95% confidence interval that did not include zero ($ab$ = 0.02, $SE$ = 0.01, 95% CI = 0.08, 0.03). When taking the mediation pathway into account, the direct effect of dichotomous thinking on BMI was still significant ($c'$ = 0.13, $SE$ = 0.04, t(3849) = 3.38, $p < .001$).

## DISCUSSION

The purpose of this study was to explore the mediating role of dichotomous thinking toward food between various eating behaviors and BMI. Multiple regression analysis revealed that there was a modest association between cognitive restraint, disinhibition, hunger, and binge eating and BMI. This is consistent with previous research showing a positive correlation between binge eating and BMI (Dakanalis et al., 2017; Guss et al., 2002; Halmi et al., 1981; Telch et al., 1988; Zelitch, 1993). However, there has not been a consistent association between dietary restraint and weight status (Hays et al., 2002; Lawson et al., 1995), as the behavior seems to be more related to the implementation of unhealthy or extreme dieting methods, independent of bodyweight (Polivy & Herman, 1985; Heatherton et al., 1988). Indeed, results from this study indicate a positive association between binge eating and BMI ($b$ = 0.13, $p < .001$) and a negative association between cognitive restraint and BMI ($b$ = -0.27, $p < .001$).

Cognitive restraint was found to be negatively correlated with BMI ($b$ = -0.27, $p$ < .001). Some data distinguish between rigid control and flexible control of dieting, and research suggests that only rigid control may be associated with higher BMI and eating disordered behaviors and attitudes, whereas flexible control was not highly associated with BMI or eating disorder symptoms (Stewart, Williamson, & White, 2002). This distinction was not made in this study, and therefore we were not able to differentiate between those who demonstrate rigid control versus flexible control. This may have contributed to the negative relationship between cognitive restraint and BMI.

Of the four predictors, disinhibition had the greatest standardized coefficient of $\beta$ = 0.28. Its unstandardized coefficient of $b$ = 0.48 tells us that every one-unit increase in disinhibition score was associated with a 0.48-unit increase in BMI. The associations between the study variables revealed that disinhibition was most highly independently associated with BMI than any of the other variables, with a value of $r$ = .35, followed closely by binge eating ($r$ = .33) and dichotomous thinking toward food ($r$ = .28). Disinhibition, or disinhibited eating, has indeed been consistently found to be the strongest predictor of weight gain, over and above dietary restraint and hunger (Hays et al., 2002; Lawson et al., 1995).

Finally, hunger was found to be negatively associated with BMI. This was an unexpected finding, as the research suggests either a positive association (Bosci, Iorio, Margiotta, D'Orsi, & Falconi, 2001; Karlsson et al., 1994; Lindroos et al., 1997; Provencher et al., 2003) or no association (Hays et al., 2002; Lawson et al., 1995). A possible explanation for this result comes from Martin, Rogers, Cook, and Joseph (2004), who found that social capital – a measure of trust, reciprocity, and social networks – was

negatively associated with hunger. Interestingly, there are increased rates of both hunger and obesity within the poorer population in the United States, as hunger reflects food insecurity, the state of being without sufficient food or money to meet basic food needs (Bickel, Nord, Price, Hamilton, & Cook, 2000; Nestle & Guttmacher, 1992), yet this does not explain the negative relationship found between hunger and BMI. As participants were not asked about social capital or income, the role of these factors could not be ascertained. Additionally, recent research found that hunger and desire to eat were significantly increased at one and two years into a weight loss program, and researchers concluded that patients with severe obesity will have to battle increased hunger in the long-term after lifestyle-induced weight loss (Coutinho, Rehfed, Holst, Kulseng, & Martins, 2018). Thus, it could be the case that higher hunger scores reflect greater weight loss achieved via behavioral intervention.

At the statistical level, one factor that may have contributed is that the negative coefficient, $b$ = -0.17, was in the context of a multiple regression analysis with other fairly highly correlated predictors that tend to correlate with hunger. Although the variance inflation factor (VIF) values for all variables were well below 10, indicating no multicollinearity, a bivariate correlation analysis found that hunger was highly independently correlated with binge eating ($r$ = .60) and disinhibition ($r$ = .61). Therefore, it is possible that there may have been some anomalous statistical circumstances. At the bivariate level, the direction of the level of the relationship was positive, which was what was predicted. Overall, the results of the multiple regression analysis were unexpected, and ultimately, uninterpretable.

The role of dichotomous thinking between various eating behaviors and BMI was also examined. The relationship between binge eating and BMI was partially mediated by dichotomous thinking, controlling for cognitive restraint, disinhibition, hunger, and yo-yo dieting. That is, thinking of food and dieting in a black-and-white polarized fashion could be a key mechanism that explains how and why binge eating is correlated with higher BMI. These results supported our hypothesis that dichotomous thinking toward food mediated the BMI-binge eating relationship.

We also found that the relationship between cognitive restraint and BMI was mediated by dichotomous thinking, controlling for disinhibition, hunger, yo-yo dieting, and binge eating; the relationship between disinhibition and BMI was partially mediated by dichotomous thinking, controlling for hunger, yo-yo dieting, binge eating, and cognitive restraint; and the relationship between hunger and BMI was not mediated by dichotomous thinking, controlling for yo-yo dieting, binge eating, cognitive restraint, and disinhibition. In short, dichotomous thinking was found to mediate all the relationships between the various eating behaviors in question and BMI except for hunger. This is unsurprising given that dichotomous thinking has been found to be a significant predictor of weight regain through the development of rigid dietary rules and subsequent binge eating (Byrne et al., 2004). Given that cognitive processes play a large role in cognitive restraint, disinhibition, and binge eating – as opposed to hunger, which is more of a physiological behavior – it makes sense that dichotomous thinking would explain these relationships.

The reverse mediation model revealed that binge eating also explained the relationship between dichotomous thinking and BMI. Thus, it could be the case that

thinking of food in black-and-white leads to higher rates of binge eating, and the excess calorie consumption could then lead to the increased BMI.

In order to further explore the relationship between yo-yo dieting and eating behaviors, post-hoc analyses were conducted. A multiple regression analysis was first conducted in which yo-yo dieting, binge eating, cognitive restraint, disinhibition, and hunger were entered as predictors of BMI. Controlling for binge eating, cognitive restraint, disinhibition, and hunger, yo-yo dieting was found to be a significant positive predictor of BMI, $p = .03$. Next, a mediation analysis was run in which dichotomous thinking was entered as a mediator between yo-yo dieting and BMI controlling for binge eating, cognitive restraint, disinhibition, and hunger. The 95% confidence interval for the indirect effect of yo-yo dieting on BMI, (-0.02, 0.02), did include zero, therefore indicating a non-significant mediation pathway at the $p < .05$ level. The direct effect of yo-yo dieting on BMI controlling for DTES, however, was significant ($c' = 0.43$, $SE = 0.20$, $t(3849) = 2.13$, $p = .03$). This tells us that in this dataset, dichotomous thinking did not explain the relationship between yo-yo dieting and BMI. While some previous research found no association between yo-yo dieting and subsequent weight loss (Wadden et al., 1992; van Dale & Saris, 1989; Beeson et al., 1989; Palm, Schram, Swarts, van Schothorst, & Keijer, 2017), the findings from this analysis align with other research suggesting a negative correlation between yo-yo dieting and weight loss (Jeffrey et al., 1984; Jeffrey et al., 1985; Miller & Parsonage, 1975; Smith & Wing, 1991).

Because previous research suggests that yo-yo dieting is correlated with increased hunger and decreased cognitive restraint (Kensinger, Murtaugh, Reichmann, & Tangney, 1998), further post hoc analyses were carried out to investigate the presence of this

relationship in this sample. A multiple regression analysis in which binge eating, cognitive restraint, disinhibition, and hunger were entered as predictors of yo-yo dieting revealed that cognitive restraint was not significantly correlated with yo-yo dieting, controlling for binge eating, disinhibition, and hunger and, similarly, hunger was not significantly correlated with yo-yo dieting, controlling for binge eating, cognitive restraint, and disinhibition. The lack of consistency in these findings may reflect the fact that yo-yo dieting status in this study was determined only by whether or not the participant had regained 10 lbs or more since the conclusion of dieting in the past five years rather than other important variables such as number of weight cycles.

## LIMITATIONS

There are several limitations to this study that should be taken into consideration. The cross-sectional nature of the study did not allow for inferences to be made regarding the causality and directions of the relationships between variables. The study was based on self-reported data, and therefore the responses may not have been all accurate. Despite the survey being anonymous, some participants may have altered their responses to certain questions based on social desirability. The length of the survey may have also influenced participants' willingness to think each question through and answer as honestly as possible.

As the informed consent letter noted that the study concerned eating behaviors, it could be the case that those with a particular interest in eating behaviors or dieting were more likely to volunteer for the survey.

Many people underreport their calorie intake, but a higher proportion of individuals who are obese underreport their intake (Lichtman et al., 1992). While

participants in this survey were not asked specifically about their calorie intake, it is possible that some individuals may have exaggerated or misreported their eating behaviors.

Additionally, although participants were asked about their weight loss and weight gain history over the past several years, they were not asked if they had become pregnant during that same period. Therefore, anyone who had been pregnant would have answered "Yes" to having gained 10 lbs or more in recent years. We also did not distinguish between individuals who intentionally gained back bodyweight (such as those who were trying to gain muscle) versus those who desired to maintain the weight loss over the long-term, nor were the participants asked about how many times they had lost and regained weight over the past five years. This would have affected the proper classification of participants as yo-yo dieters. While we could have asked question 9 on the Questionnaire on Eating and Weight Patterns Revised (QEWP-R), which states, "How many times (approximately) have you lost 20 lbs (9.1kg) or more when you weren't sick and then gained it back?" that still would not have differentiated between those who gained the weight back intentionally versus not.

Body mass index is only a surrogate measure of body fat and is unable to distinguish between variables including bone density and muscle mass. An individual who strength trains regularly and has a high amount of muscle mass on her frame, for example, may actually be at a healthy body fat level, but her BMI may categorize her as overweight or even obese. An individual who lives a healthy lifestyle may therefore receive a poor BMI score, and this information can be misleading. Additionally, body fat increases and muscle mass decreases with age (Rothman, 2008), and BMI also does not

take into consideration changes in fat distribution (Coutinhoe et al., 2011), and studies based on self-reported height and bodyweight can be imprecise (Dutton & McLaren, 2014).

Because the participants in the study were all female, we are unable to generalize our findings to the male population. This is important because there is increasing research suggesting that disordered eating and other eating behavior-related problems are a growing concern amongst males (Strother, Lemberg, Stanford, & Turberville, 2012). The 2008 National Institute of Mental Health reports that roughly one million men in the United States have eating disorders, and this condition is likely to be underreported.

## CONCLUSION

The longer weight loss is maintained, the higher the likelihood that it will be kept off over the long-term (McGuire, Wing, Klem, Lang, & Hill, 1999; Wing & Hill, 2001), in part because individuals use increasingly less effort to maintain their weight (Klem, Wing, Lang, McGuire, & Hill, 2000). Brownell, Marlatt, Lichtenstein, & Wilson (1986) suggest that they adopt critical behaviors and skills that protect against weight regain. As a behavior is practiced and repeated over time within a similar context, the cognitive processes required to execute the behavior become more automatic, eventually requiring little conscious effort or attention (Ouellette & Wood, 1998). When this happens, the behavior can be conceptualized as a habit, which is defined as the tendency to repeat specific behavioral responses.

Participants in this study were not asked about the length of time for which they had maintained their weight loss, if at all, nor were their various eating behaviors assessed for habit strength. This is relevant as we did not glean any information about

daily lifestyle and eating habits that could have provided more insight into how and why some participants were successful at maintaining a lower bodyweight than others.

The findings from this study are consistent with Polivy's recommendations (1996) that individuals should be encouraged to live a healthy lifestyle consisting of regular exercise, a balanced diet, and no restrictions on any particular food. For those who are overweight or obese, learning how to enjoy their favorite foods in more moderate portions – thus, reducing overall calorie intake – rather than exercising as much dietary restraint as possible should be encouraged for best long-term weight loss outcomes. In particular, dichotomous thinking seems to play an important role in explaining the relationship between various cognitive eating behaviors and BMI. Thus, increasing efforts to emphasize the importance of not labeling foods as "good" or "bad" and instead on establishing a healthy, balanced relationship with nutrition that does not involve dietary extremes could be a critical component of maintaining a lower bodyweight over the long-term.

Future research should include both male and female participants and should involve longitudinal research to further explore the impact of dichotomous thinking toward food on these variables over time. A longitudinal study would provide more insight into the role of dichotomous thinking toward food and other variables in measures of weight loss maintenance.

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# APPENDIX A

# PASSIVE CONSENT

**The mediating role of dichotomous thinking toward food on various eating behaviors and BMI**

I am a graduate student under the direction of Professor Robles-Sotelo at the College of Social and Behavioral Sciences at Arizona State University. I am conducting a research study to assess the relationship between cognitive factors and various eating behaviors.

I am inviting your participation, which will involve completing three short questionnaires. Participation will take approximately 20 minutes. You have the right not to answer any question and to stop participation at any time.

Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. You must be 21 years of older to participate in the study.

There are no benefits to your participation, and there are no foreseeable risks or discomforts to your participation.

All data you provide us will be stored on password-protected devices. Furthermore, your name will be omitted from all data sets. Thus, your responses will be anonymous. The results of this study may be used in reports, presentations, or publications, but your name will not be used.

If you have any questions concerning the research study, please contact the research team at: (Dr. Elias Robles-Sotelo at Elias.Robles@asu.edu or myself at slee400@asu.edu). If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788.
By clicking on the link below, you are agreeing to be part of the study.

Thank you,

Sohee Lee

# APPENDIX B

# IRB EXEMPTION LETTER

ASU Knowledge Enterprise Development

EXEMPTION GRANTED

Elias Robles-Sotelo
NEW: Social and Behavioral Sciences, School of (SSBS)
602/543-4515
Elias.Robles@asu.edu

Dear Elias Robles-Sotelo:

On 10/2/2017 the ASU IRB reviewed the following protocol:

| | |
|---|---|
| Type of Review: | Initial Study |
| Title: | Duration of beneficial effects following the discontinuation of dietary protocols |
| Investigator: | Elias Robles-Sotelo |
| IRB ID: | STUDY00006999 |
| Funding: | None |
| Grant Title: | None |
| Grant ID: | None |
| Documents Reviewed: | • Protocol2 10-02-17.docx, Category: IRB Protocol;<br>• Initial Recruitment Letter.pdf, Category: Recruitment Materials;<br>• Survey materials, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);<br>• Consent Form.pdf, Category: Consent Form; |

The IRB determined that the protocol is considered exempt pursuant to Federal Regulations 45CFR46 (2) Tests, surveys, interviews, or observation on 10/2/2017.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

APPENDIX C

TABLE 1

Participant demographics and descriptive statistics

| Variable | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|
| Age | 34.63 | 8.61 | 21 | 55 |
| Height (m) | 1.64 | 0.10 | 1.22 | 2.03 |
| Bodyweight (kg) | 73.89 | 18.43 | 32.66 | 158.76 |
| BMI | 27.70 | 6.79 | 12.06 | 51.06 |
| DTES | 9.58 | 3.30 | 4 | 16 |
| BES | 13.70 | 9.39 | 0 | 46 |
| Cognitive Restraint | 11.06 | 4.31 | 0 | 21 |
| Disinhibition | 8.27 | 3.93 | 0 | 16 |
| Hunger | 6.04 | 3.64 | 0 | 14 |

Note: BMI - Body Mass Index; DTES - Dichotomous Thinking in Eating Subscale; BES - Binge Eating Scale

APPENDIX D

TABLE 2

*Distribution of BMI Categories (N = 3,893)*

| BMI Category | Frequency | % |
|---|---|---|
| Very Severely Underweight | 9 | 0.23 |
| Severely Underweight | 3 | 0.08 |
| Underweight | 65 | 1.67 |
| Normal | 1657 | 42.56 |
| Overweight | 994 | 25.53 |
| Moderately Obese | 543 | 13.95 |
| Severely Obese | 351 | 9.02 |
| Very Severely Obese | 271 | 6.96 |

APPENDIX E

TABLE 3

*Correlations for variables in Hypotheses 1 and 2*

| Variable | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| BMI | | | | | | |
| DTES | .28** | | | | | |
| BES | .33** | .63** | | | | |
| Cognitive restraint | -0.13** | .27** | .12** | | | |
| Disinhibition | .35** | .56** | .79** | .10** | | |
| Hunger | .18** | .37** | .60** | .04** | .61** | |
| Yo-yo dieting | .06** | .06** | .07** | 0.02 | .08** | 0.04 |

Note: **$p < .01$, *$p < .05$; BMI - Body Mass Index; DTES - Dichotomous Thinking in Eating Subscale; BES - Binge Eating Scale

APPENDIX F

TABLE 4

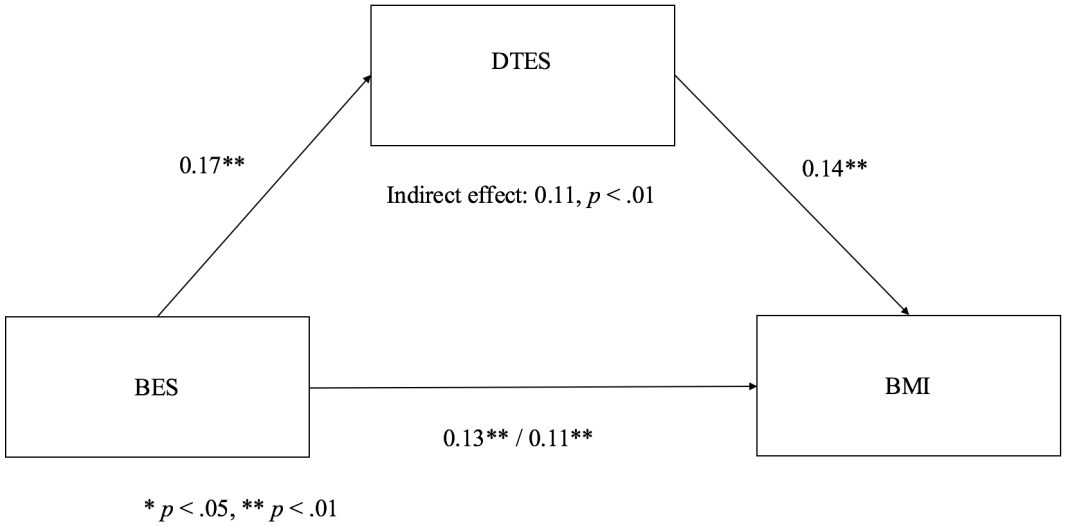
*Multiple regression for binge eating, cognitive restraint, disinhibition, and hunger predicting BMI*

| Variable | *B* | *SE B* | *β* | Sig. |
|---|---|---|---|---|
| BES | 0.13 | 0.12 | .19 | <.001** |
| Cognitive Restraint | -0.27 | 0.02 | -.17 | <.001** |
| Disinhibition | 0.48 | 0.04 | .28 | <.001** |
| Hunger | -0.18 | 0.04 | -.09 | <.001** |

*Note:* ***p* < .001; *B* – unstandardized regression coefficient; *SE B* – standard error of unstandardized regression coefficient; β – Beta; BES – Binge Eating Scale

# APPENDIX G

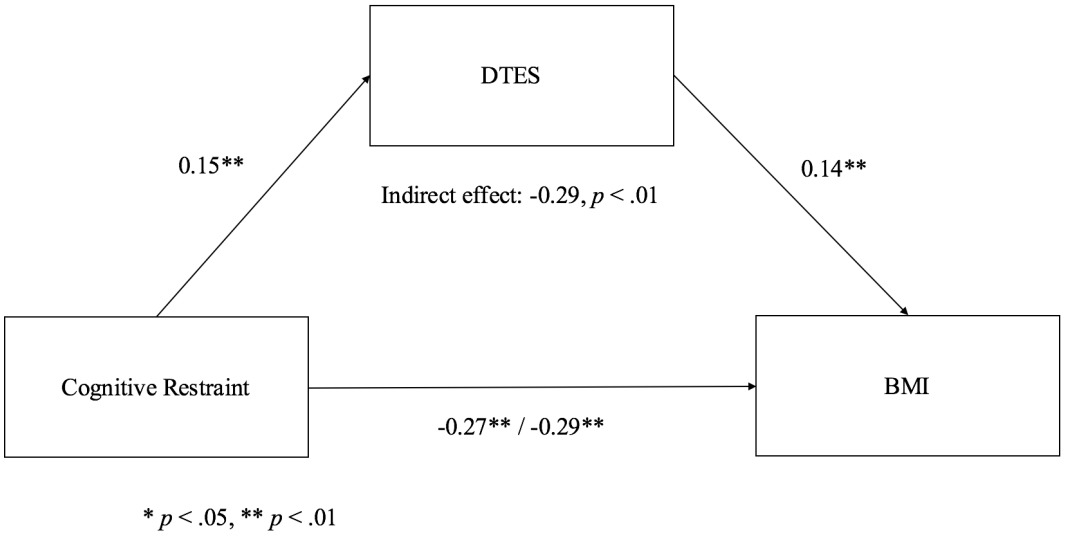
## FIGURE 1




Dichotomous thinking toward food as a mediator of the relationship between binge eating and BMI controlling for cognitive restraint, disinhibition, hunger, and yo-yo dieting

APPENDIX H

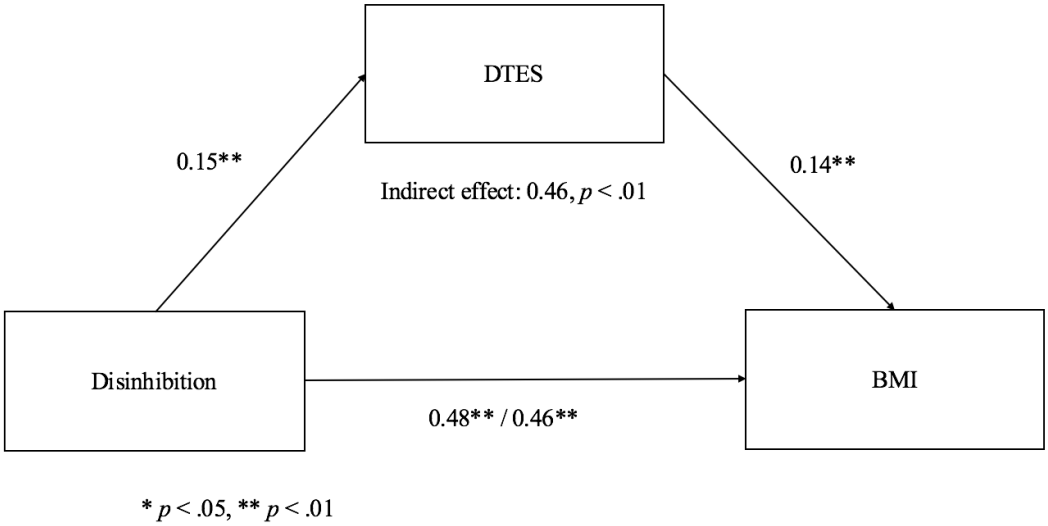
FIGURE 2




Dichotomous thinking toward food as a mediator of the relationship between cognitive restraint and BMI controlling for binge eating, disinhibition, hunger, and yo-yo dieting

APPENDIX I

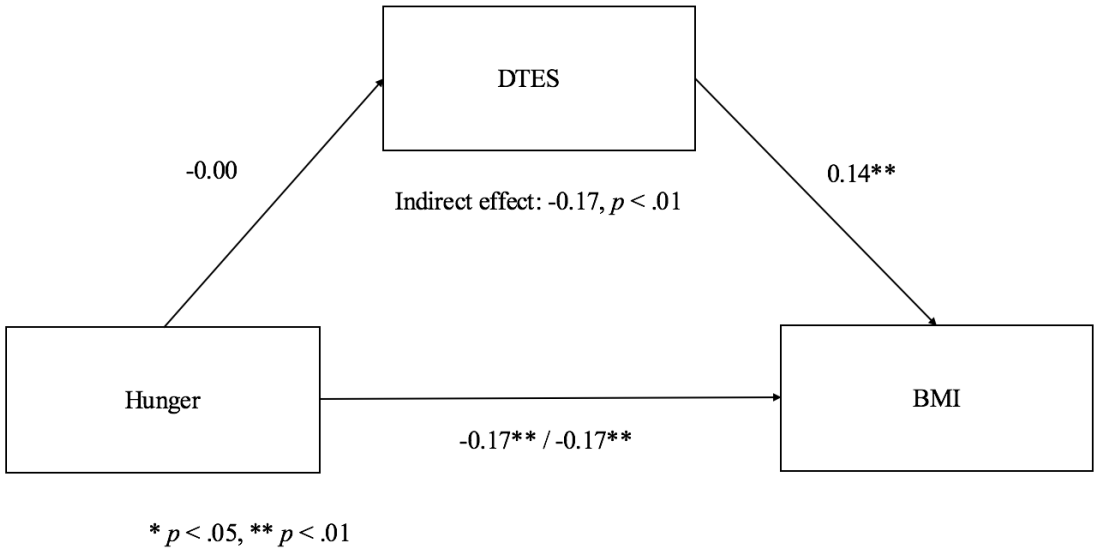
FIGURE 3




Dichotomous thinking toward food as a mediator of the relationship between disinhibition and BMI controlling for binge eating, cognitive restraint, hunger, and yo-yo dieting

APPENDIX J

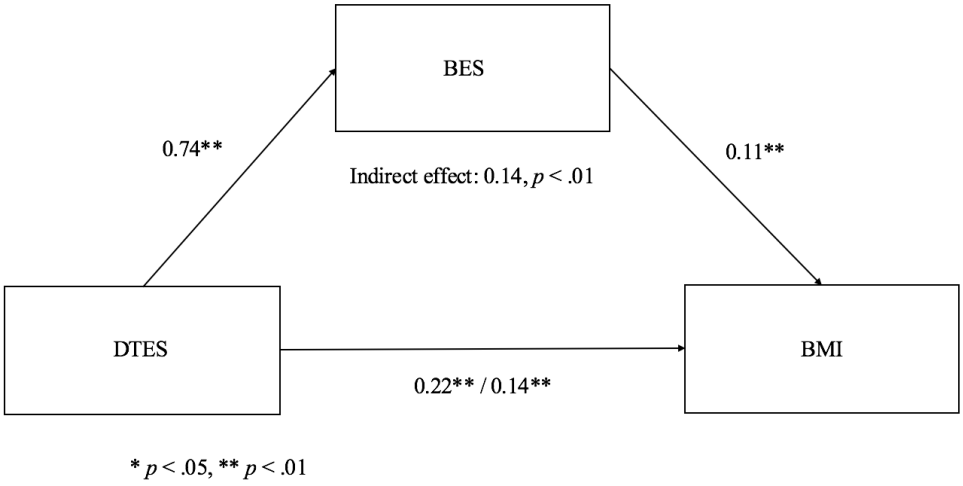
FIGURE 4




Dichotomous thinking toward food as a mediator of relationship between hunger and BMI controlling for binge eating, cognitive restraint, disinhibition, and yo-yo dieting

# APPENDIX K

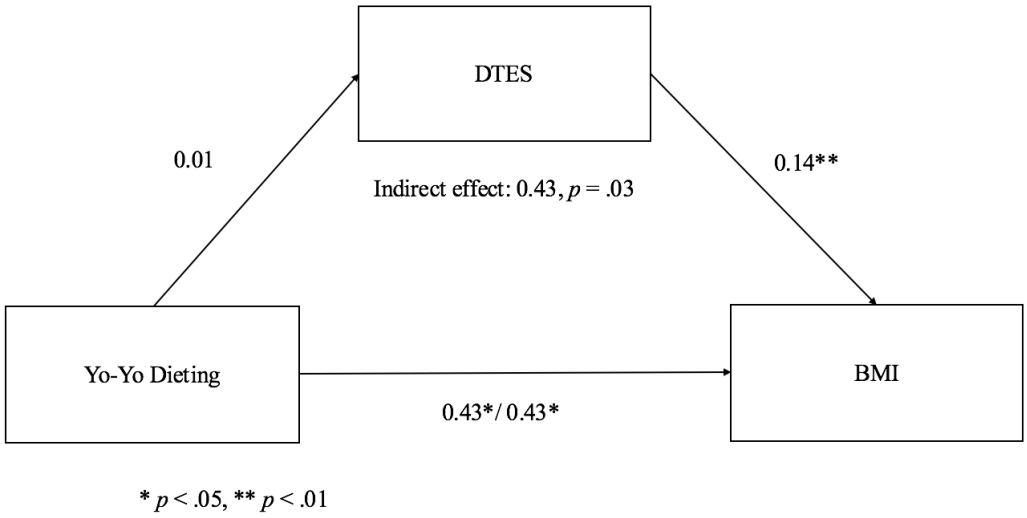
## FIGURE 5




Binge eating as a mediator of relationship between dichotomous thinking toward food and BMI controlling for cognitive restraint, disinhibition, hunger, and yo-yo dieting

APPENDIX L

FIGURE 6




Dichotomous thinking toward food as a mediator of the relationship between yo-yo dieting and BMI controlling for binge eating, cognitive restraint, disinhibition, and hunger